attempted during the whole of the proceedings, which lasted about a quarter of an hour, to bite the frog. The frog was removed quite uninjured, but apparently exhausted either by fear or by muscular exertion. T. MARTYR

St. Joseph's College, Clapham, S.W.

Hybrids between the Black Grouse and the Pheasant

IN Yarrell's "British Birds," 4th ed. vol. iii. p. 69 *seq.*, a number of hybrids between the cock pheasant and the gray hen are enumerated as having occurred in England. Being desirous to give a life-sized and coloured figure of such a hybrid in my forthcoming work on the black grouse, the capercailzie, and their allies, I wish to borrow a specimen for a short time, and, as my endeavours to procure one have so far been unsuccessful, I beg to make this known through your widely read journal, hoping that some fortunate possessor may be kind enough to communicate with me concerning his willingness to lend me a specimen for the said purpose. A. B. MEYER

Royal Zoological Museum, Dresden, July 5

THE FINSBURY TECHNICAL COLLEGE CONVERSAZIONE

THE annual *conversazione* given by the students of the above College as the closing event of the session came off on Friday evening, July 2, and proved in every way a success. The large number of interesting objects brought together for exhibition certainly speaks well for the activity of the various committees which were intrusted with the work of organisation, and at the same time indicates how widely spread is the interest shown in the welfare of the College by the different firms of manufacturers who contributed to the exhibition. The electrical department exhibited in action most of the apparatus used for educational purposes in the College. In this department also were exhibits of apparatus and models by Messrs. Woodhouse and Rawson, the Electric Apparatus Company, Messrs. Mayfield's vacuum-tubes, and other electrical and physical apparatus made by this firm. The exhibits in the chemical department were especially numerous and representative of chemical technology in most of its branches. In the way of apparatus Messrs. Cetti, of Brooke Street, exhibited barometers, thermometers, vacuum-tubes, &c.; Messrs. Townson and Mercer showed a new carbonic acid generator, Schutzenberger's gas apparatus, filter pumps, nickel crucibles and basins, Pasteur flasks, inland revenue stills, Abel's petroleum testing apparatus, &c.; and Mr. B. Redwood lent a set of viscometers. Fine chemicals were exhibited by Messrs. Hopkin and Williams, and a splendid set of alkaloids and other products by Messrs. Howard of Stratford. Messrs. Pontifex and Wood exhibited sets of pigments and the materials used in their manufacture, Mr. C. Richardson a set of specimens illustrating the manufacture of cements, Mr. Ashley samples of English and foreign lubricating oils, and Messrs. J. and L. Cripps the materials and finished products representing the manufacture of size, glue, and gelatine. Glass manufacture was represented by a set of tools and specimens from the Whitefriars glass-works (Messrs. Powell). Messrs. Field showed a fine series of waxes and other materials used in candle-making, and a good exhibition was made also by Price's Patent Candle Company. The manufacture of soap was illustrated by a very complete set of specimens contributed from Messrs. E. Rider Cook's works at Bow and by Messrs. Knight, &c. Cotton seed and its products were shown by Messrs. W. and W. H. Stead of Blackwall and Liverpool. The specimens and diagrams sent by Gaskell, Deacon, and Co., of Widnes, gave an excellent idea of the alkali manufacture in this country.

The collection of coal-tar products was especially rich, specimens having been sent by the Badische Company, the Hoechst Colour Works, Messrs. Brooke, Simpson, and Spiller, the British Alizarine Company, and Messrs. Burt, Boulton, and Haywood. The latter firm exhibited a splendid model of their timber creosoting plant. Amongst other tar products was a set of preparations of the new sweetening substance, saccharine, sent by Dr. Fahlberg. The Broadburn Oil Company showed a very complete set of shale products. The sugar industry was represented by a set of polarimeters, models and specimens, exhibited by Mr. Newlands of the Clyde Wharf Sugar Refinery, and by the Beetroot Sugar Association. In the course of the evening Prof. S. P. Thompson gave a lecture on waves of light and Mr. John Castell-Evans discoursed on explosives. The entertainment was on the whole highly creditable to the College, and many of the firms who sent objects for exhibition have signified their approval by presenting their exhibits to the establishment as lecture specimens.

THE RECENT DISCOVERIES AT TIRYNS[1]

THE excavations made during the last two years at Tiryns, by Dr. Schliemann and Dr. Dörpfeld, have thrown new light on what has been hitherto an almost unknown period of Greek history—that far-off time, more remote even than the age of the Homeric poems, when Hellenic civilisation had not yet emerged from its Oriental cradle, nor developed its highly cultured systems of social and political government out of the splendid but semi-barbarous tyrannies of Western Asia Minor.

The literature of Greece has made us familiar with the later times, when the individual was for the most part merged in the State, and when the wealth and artistic skill of each city was devoted to public uses, such as the Council-chamber, the Agora, or the stately temples of the gods, rather than to the luxury of any one person.

But at Tiryns a very different picture is presented to us: we see a single autocratic chieftain, ruling in a sort of feudal state, and occupying a magnificent palace, surrounded by the humbler dwellings of his circle of retainers; while, instead of the utmost resources of the architect, the sculptor, and the painter being lavished on the shrine of the presiding deity, a mere open-air altar is dedicated to the god, and it is the chieftain's house which is decked out with the splendours of gilt bronze, marble sculpture, and painted walls.

The rock in the marshy plains of Argolis, on which stands the citadel of Tiryns, is about three miles distant from the Gulf of Nauplia, and commands an extensive view reaching from Argos, with its rich olive-groves, to Mycenæ on its lofty crags, and, between the two, the once prosperous sea-port of Nauplia, by the blue waters of its sheltered bay.

The massive fortification wall which surrounds the Tirynthian Rock was an object of wonder and admiration in the earliest historic times of Greece: its enormous stones keenly aroused the Greek imagination, and created legends which attributed them to mysterious Cyclopean builders, and peopled the walls with the demi-gods of the heroic age, such as Perseus and Heracles, whose early youth was fabled to have been spent in the Tirynthian city—the *Τίρυνς τειχίοεσσα* of Homer's "Iliad." This wonderful wall, some stones of which are no less than 11 feet long and 4 feet thick, was originally nearly 50 feet high at its loftiest part, measuring from its base outside: inside the city the height was very much less, as its lower part acted as a retaining wall, which kept up the loose earth which formed a level interior surface above the irregular contour of the rock.

The southern part of the Acropolis wall, where it incloses the great palace, is a very complicated structure, containing long rows of small vaulted chambers averaging about 14 feet by 12, all opening into a long vaulted passage, the whole formed in the thickness of the wall itself, which at some places consists of nearly 40 feet of masonry. Two stories of these chambers existed, one above the other: the lower story is of solid stone masonry, built of large hammer-dressed blocks, bedded in clay cement. The upper tier of chambers was built of sun-baked bricks, like the upper part of the wall round Athens, carefully protected from the weather by coatings of very hard durable stucco. This top story of rooms opened into a long open *loggia* or colonnade, with a flat roof supported by a range of wooden columns, each on a stone footing block.

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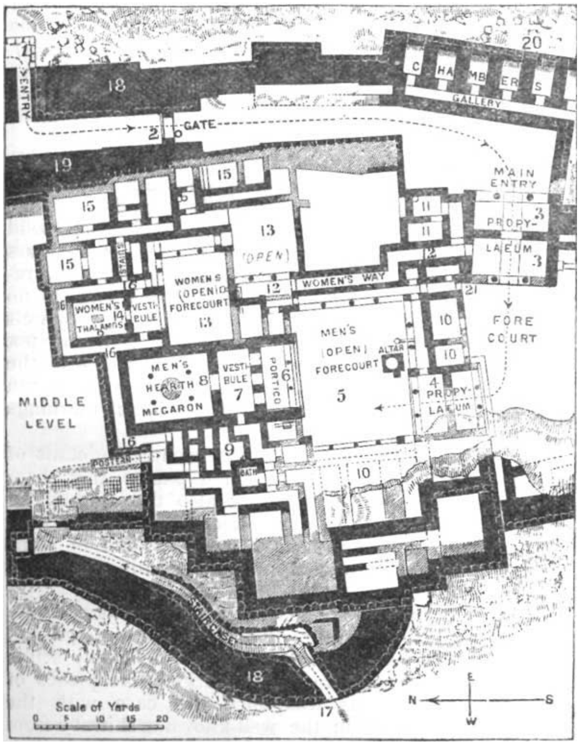
[1] "The Prehistoric Palace of the Kings of Tiryns." The results of the latest excavations, by Dr. Henry Schliemann. The preface by Prof. F. Adler, and contributions by Dr. Wm. Dörpfeld. With 188 woodcuts, 24 plates in chromolithography, 1 map, and 4 Plans. (London: John Murray, 1886).

The columns themselves are of course no longer in existence, but their size and positions are clearly shown by the stone base on which each stood. These extensive series of chambers in the wall of Tiryns served, no doubt, to accommodate the garrison of the place—exactly as was the case in the Phœnician cities of Thapsus and Carthage. The enormous number of 24,000 men are said to have had lodging in the walls of the Carthaginian Acropolis (Appianus of Alexandria, "Hist. Rom.," i. p. 220), and recent discoveries have shown that this statement may very possibly have been no exaggeration.



PLAN OF THE PALACE MEASURED BY DR. DÖRPFELD.

1, Main gate in outer wall; 2, inner gate; 3, main propylæum; 4, inner propylæum; 5, court of the men with surrounding cloister, 6, aithousa, or portico; 7, prodomos, or vestibule; 8, men's hall; 9, bath room and small chambers; 10, chambers round the court; 11, guard-room by the propylæum; 12, passage from propylæum to the women's part; 13, 13, courts of the women; 14, women's hall; 15, chambers of the women's part; 16, 16, passage from the women's part to the outer postern; 17, postern door, approached by rock-cut steps; 18, outer wall of Acropolis; 19, inner wall of entrance passage; 20, outer wall with rows of chambers; 21, side entrance to men's court.

More than a third of the whole Acropolis of Tiryns was occupied by the palace of its ruler—a very complicated building designed with much architectural skill, and showing complete uniformity of design combined with very distinct adaptation to a clearly defined purpose.

With the exception of three very narrow posterns, there is only one entrance into the citadel; and this is very skilfully contrived so as to make its defence as easy as possible.

After breaking through the outer gate, which was commanded by a tower on the right or unshielded side of the enemy, the assailants would have found themselves in a narrow passage with massive walls on both sides, and strong inner gates at each end; and in this cramped space would be subjected to a heavy fire of missiles poured down upon them from all sides.

After passing the inner gate in a southern direction, a handsome propylæum or porch was reached: this was decorated on both sides by a portico of two columns *in antis*, and is very similar in plan to the propylæum of the sacred inclosure at Eleusis—a work of the fifth century B.C. (See the accompanying woodcut of the plan.)

After passing through an open court, a second propylæum of similar design was reached, and then the visitor found himself in the cloistered court of the men's part of the palace. In the central open space stands the altar to Zeus Herkeios, which is frequently named in the Homeric poems, built over a small pit cut in the rock, into which would fall the blood and ashes from the burnt offering on the altar above. Opposite the entrance to the court is the great hall or Megaron (about 40 feet by 32), approached through an open-columned portico and an inner vestibule. The roof of the hall was partly supported on four wooden columns, which appear to have carried an open "lantern," formed to carry off the smoke from the fire, which burnt on a round hearth in the middle of the room; very much as was the case in the hall of a mediæval house or college.

On the west side of the hall of the men are a number of small chambers—probably the sleeping-apartments of the bachelor members of the family. One small room, about 12 feet by 10, is of extraordinary interest. It is evidently a bath-room; its floor is formed of one enormous slab of stone, carefully chiselled so as to drain out at one point where a stone drain-pipe is carried through the wall, and so into the main drain of the house.

The bath itself, in size and form very like a modern one, was of terra-cotta decorated with a spiral ornament in red.

The walls of the bath-room were lined with wooden planks about 10 inches wide; their lower ends were fastened by wooden dowels to the stone flooring block, the edge of which all round the room is raised slightly where the wood wall-lining rested on it: evidently in order that water splashed on the stone floor might not soak under the wood lining; a piece of refinement which shows much thought and labour spent on matters of detail.

The eastern half of the palace consists of the apartments reserved for the women and the married members of the chief's family. This also has a hall with a central hearth, and is approached through a single vestibule from another open court. The smaller rooms, of which there are a great many, on this side appear to have been two stories high: traces of the staircase still exist.

Though a separate group of apartments appears to have been provided for the women, yet they were by no means shut off from ready access either to the outer world, or to the men's part of the house. There are at least three ways by which the women's rooms could be reached: one from the side of the outer propylæum, another through the court of the men, and lastly a long passage leads round the back of the men's hall to the long flight of rock-cut steps leading down to the postern in the semi-circular bastion. Another door at a higher level gave direct communication between the hall of the men and the apartments of the women.

The walls of this palace were built of roughly-dressed stone bedded in clay up to a height of about 2 feet above the ground: the rest of the wall was of sun-dried brick; the whole was then covered inside and out with three coats of stucco made of lime mixed with sand, gravel, and broken pottery, a mixture which set nearly as hard as stone, and must have been a most perfect protection even in the stormiest weather. Finally, where the stucco was to be painted a thin coat of pure lime was applied as a ground for the colours, which consisted of red, yellow, and brown ochres, with charcoal-black and lime-white; and lastly, blue and green *smalti* or pigments, made of powdered glass. All these colours were of the most durable sort, and could be applied, as appears to have been done at Tiryns, on freshly-laid stucco—true *fresco*.

The painted decorations are of the very highest interest, and very characteristic examples of primitive art, which show strong traces of Egyptian or Phœnician influence. Some of these wall-paintings are evidently copied from textile patterns, and, though rudely executed, have much true decorative value. Woven stuffs such as were made in Egypt are imitated by the painter, and even the fringes are carefully copied. Other pictures, of which only fragments remain, had large figures of animals or men with wide-spreading wings, the feathers of which are painted in alternating colours in a very brilliant and skilful way. These show strong signs of Phœnician influence. The most remarkable and best preserved of all is a picture of a bull galloping at full speed, on whose back a man is riding in an acrobatic sort of way, holding on by one of the bull's horns. The whole is painted with much vigour, and with a rapid sweeping touch of the brush, which shows considerable practice and skill on the part of the painter.

Some parts of the palace were evidently decorated in a much more magnificent and costly way—that is, the walls were lined with wooden boarding, and on this were nailed plates of gilt bronze beaten into *repoussé* reliefs—very similar probably in style to the ninth century gates of Shalmaneser II., now in the British Museum, and other bronze reliefs found at Olympia. Many small fragments of these gilt metal linings were found in the burnt debris of the palace; and there is little doubt that the wooden columns in the hall and its portico must once have been cased with similar metal sheathing: very like the bronze-cased wooden column which was found some years ago among the ruins of Khorsabad.

Nothing could exceed the splendour of this mode of wall-decoration—the whole surface enriched with its gleaming reliefs would appear one mass of shining gold, and we know now that the gold and silver walls of the Homeric palace of Alcinous were not merely the offspring of a poet's fancy. Fragments were discovered by Dr. Dörpfeld of another extremely sumptuous method of architectural decoration—a frieze about 20 inches deep sculptured in alabaster with a rich and minutely worked pattern of rosettes and geometrically treated flowers, thickly studded with carefully cut bits of jewel-like transparent blue paste or glass. The effect of these deep-blue jewels flashing light from the contrasting creamy white of the alabaster must have given a most striking effect to the room which was adorned in so costly a way, especially if the wall below the frieze were one of those which were coated with the gold reliefs.

Nor was the colour confined to the walls: even the floors were decorated with simple patterns in brilliant blue and red, applied after the design had been indicated by lines incised on the surface. These floors were made of strong lime and gravel concrete carefully laid in three or four layers, each of finer material than the one below—a method exactly similar to that described by Vitruvius and used so skilfully by the Roman builders.

A very interesting point about the Tirynthian palace is its very careful method of drainage, partly with neatly fitted clay drain-pipes, and partly with large culverts built of rough stone and puddled inside with clay: this latter form was used for the main drains, while the branches which led to it were of pipes square in section, each length of clay pipe being narrowed at one end so as to fit closely into the next. All the open courts were well paved with concrete, which was laid so as to fall to a surface-gully, down which the rain-water passed, first through a clay pipe, then into the main stone drain, and so into a series of cisterns, where it was stored for use during a siege.

Much manual skill and great variety of tools were used by the masons who worked the stones for this building. Pointed hammers were used for the rough work, and chisels for the ashlar stone: the large thresholds of the various doorways were cut with a saw, with which emery must have been used, as its marks show that each stroke of the saw cut a considerable depth into the stone. Hollow drills set with some kind of hard jewel were also used here: in many of the drill-holes used to fix the pegs or dowels of the wood-work above, the stone stump of the core still exists, showing that a tubular, and not a solid, drill was used. Some of the large quoins or angle blocks were quarried thus—four drill-holes were sunk at the four corners of the future block, and then saw-cuts were made from hole to hole.

This use of tubular jewelled drills, which has recently been introduced with such effect into modern methods of engineering, dates from a very early period. As Mr. Flinders Petrie has pointed out, jewelled drills, both solid and tubular, were used in Egypt as early as 4000 years before Christ, especially in the working of the very refractory granites, basalts, and porphyries, which no unaided metal tools could possibly have cut. That jewels *fixed* in the rim of the metal tube were used, and not merely loose corundum or emery-powder, is shown by the fact that the scratch from a single projecting jewel can often be traced continuously round the spiral markings on the insides of the drill-holes.

It is not, however, only the mere technical details of the workmanship of this Tirynthian palace that bear strong witness to its early date, but also the methods of construction—the walls of sun-baked bricks set on a footing of stuccoed rubble, the use of wood instead of stone for the columns, and the magnificence of the walls lined with plates of bronze, *repoussé* and gilt.

Finally, nothing can be clearer than the evidence supplied by the semi-Oriental style of the wall-paintings, and the distinctly archaic character of the delicately sculptured alabaster frieze, studded with gem-like pieces of blue *κύανος*—exactly as was once the case with the central row of spirals in the well-known architrave from the doorway of the "Treasury of Atreus" in the British Museum, the remote antiquity of which is disputed by no one. In fact the methods of execution, the system of its construction, and the style of its decoration all combine to show that we owe to Dr. Schliemann and Dr. Dörpfeld the discovery of an almost new phase of prehistoric Greek art.

J. H. M.

ON VARIATIONS OF THE CLIMATE IN THE COURSE OF TIME[1]

If we examine the meteorological charts of Norway we observe at once what a great influence the sea and the mountains exercise over the climate in various parts. Nearly all the climatological lines run more or less with the shape of the coast, so that we encounter far greater variation when proceeding from the centre coastwards

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[1] The following is a short abstract from various papers, viz.: "Essay on the Immigration of the Norwegian Flora during Alternating Rainy and Dry Periods" (Christiania, 1876). "Die Theorie der wechselnden kontinentalen und insularen Klimate," in Engler's *Botanische Jahrbücher*, ii. (Leipzig, 1881). "Ueber Wechsellagerung und deren mutmassliche Bedeutung für die Zeitrechnung der Geologie und für die Lehre von der Veränderung der Arten," in *Biologisches Centralblatt*, iii. (Erlangen, 1883). "Ueber die wahrscheinliche Ursache der periodischen Veränderungen in der Stärke der Meeresströmungen" *l.c.* iv. (Erlangen, 1884).